

wherever possible results have been found by rational rather than empirical methods. The design of a steam boiler, so far as strength is concerned, is a matter in which the designer has but small latitude. In this country he has generally to make the results of his calculations conform to the rules of the Board of Trade, or of Lloyd's Committee, or of both. Hence the book will be of greater service to the student than to the practical designer, although there is much in it which will appeal to the latter also.

Naturally much reference has been made to the Massachusetts Boiler Rules, which have been used as a model by many States and adopted bodily by others. It is of interest to note that, with certain exemptions, these rules provide that all boilers shall be inspected when installed and annually thereafter by the inspection department of the district police, under supervision of the chief inspector of boilers. In this country the periodic inspection of land boilers is left to the owner, who generally delegates the matter to his insurance company. If the boiler is not insured, periodic and competent inspection may, or may not, be carried out, and depends entirely on the owner's workmen or engineer.

The book is well illustrated and contains several fully worked out designs. These, and the methods of calculation, are of considerable interest and will be of service to engineers in this country who wish to acquaint themselves with up-to-date American practice in boiler design.

Mechanical Drawing, with Special Reference to the Needs of Mining Students. By J. Husband. Pp. 79. (London: Edward Arnold, 1915.) Price 3s. net.

READERS of this excellent text-book will have a feeling of satisfaction that a piece of good work, evidently much needed, has been conceived and carried out in a thoroughly efficient manner. Teachers and students connected with mining and colliery engineering are much indebted to the author for putting at their disposal, in a convenient form, material which will specially appeal to them and will prove most helpful in the drawing classes and an incentive to study.

The course is progressive, beginning with some excellent advice on the selection and manipulation of drawing instruments. The well-executed drawings are fully and clearly detailed and dimensioned, and the descriptions are always suggestive in pointing out the leading features of a design, and are models of conciseness and lucidity.

The examples selected are welcome on account of their freshness, importance, and suitability. In order to give an idea of the scope of the work we may instance the plates on bolt and rivet fastenings; built-up work, such as stanchions, girders and pump quadrants; pedestals, shafts and axles for wagons and winding engines; mine cages and colliery tubs; haulage clips and safety hooks; mine pumps; pneumatic hammer drills.

We strongly recommend teachers of elementary machine drawing to consult this most useful manual.

LETTERS TO THE EDITOR.

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The Use of Cotton for the Production of Explosives.

WHILE in no way attempting to dispute the authority of the writer of the article on gun-cotton in NATURE of July 1, I should like to take the opportunity of expressing my surprise at the conclusions there reached. On general grounds one would anticipate that plant-products, such as cellulose and alcohols, could be prepared in any country, so long as plants grew; they stand in sharp distinction from metals and petrol, which are not of universal occurrence.

It scarcely seems likely that the suitability of cotton as the cellulose basis for certain explosives can be due entirely to chemical peculiarities, for although cotton is a typical cellulose it contains many impurities—mineral salts, dead protoplasm, cuticle, waxes. These cannot all be entirely removed in course of manufacture, and it is presumably their presence which necessitates the very careful blending employed in preparing cotton for nitration. It seems more likely that the matter is one of physical properties, the thin-walled, hollow, pitted cylinders of the cotton hairs offering a large surface to reagents.

But if this were the prime advantage of cotton, it is not one which need inhibit the use of other forms of cellulose for the making of "gun-cotton." Even the best cotton is by no means uniform from hair to hair, and the waste cotton used for nitration is still more irregular; consequently, it seems likely that an artificial cellulose might be made even more uniform than cotton. It would scarcely be possible to make such a product with the same ratio of surface to mass as is found in natural cotton hairs, but this ratio could at least be made constant, e.g. by dissolving the cellulose and squirting thin threads of it, in the form of "artificial silk." The trade in these artificial silks is mainly Continental, and has been developing rapidly during the last ten years, so that there should be no lack of knowledge of the process in Germany.

Undoubtedly "gun-cotton" made in this way would be quite different from true gun-cotton. All values would have to be re-computed; the trajectory, with the sighting and timing, would be altered, and a great deal of extra work would be thrown on all concerned, but with all submission to the chemists, to whose domain this matter belongs, I venture to think that it may be possible to turn out perfectly uniform "gun-cotton" with cellulose derived from plants other than cotton. The question of cost is immaterial in the circumstances, and although it cannot be doubted that the cutting off of Germany's cotton supplies would hinder the German guns, yet it seems likely that a fairly effective substitute might be devised by the nation of technologists.

Carlyle may be quoted in this connection. "Inter-rupted Commerce and the British Navy shut us out from saltpetre; and without saltpetre there is no gun-powder. Republican Science again sits meditative. . . . What of saltpetre is essential the Republic shall not want."

W. LAWRENCE BALLS.

Little Shelford, Cambridge, July 7.

I HAVE read not only with interest, but also, I hope, with some instruction to myself, the admirable letter from Mr. Balls which you have been kind enough to let me see. I am entirely in accord with him in his

view that as long as plants grow so long will cellulose be formed, and with this as a basis nitro-cotton can certainly be prepared. I do not wish to convey the idea that the reason why cotton waste is chosen for making nitro-cotton is its chemical idiosyncrasies, but rather that it is the most abundant and fairly uniform stuff which is available for practical use. Mr. Balls is quite right in thinking that the physical structure of cotton fibre has much to do with the applicability of cotton for making propulsive explosives, but this cuts both ways, because even cotton is troublesome in that those fibres tend to retain acid, which has to be removed by regulated boiling and washing. Hence the suggestion that an artificial "cotton" might be used is well worth considering—dissolved and squirted cellulose being necessarily fairly uniform—and I agree with Mr. Balls that it would not only be possible but also tolerably easy to turn out perfectly uniform gun-cotton made this way.

Nobody has denied from the beginning of the discussion which has taken place in the Press on the subject of cotton for explosives, that nitro-cotton can be prepared from any source of nature which can provide us with cellulose, but the issue is really rather different. It is impracticable for a factory accustomed to using a particular raw material so to alter its operations as to use another raw material without great delay, expense, and in this case much danger. The other difficulty has been mentioned by Mr. Balls, and is that of the artillerist who, given even a better nitro-cotton than that to which he is accustomed, would have to learn his art all over again, and meanwhile it is of more advantage to his country that he should be sighting his gun in the manner to which he is accustomed. To use a homely expression, it is generally a mistake to swap horses in a stream.

THE WRITER OF THE ARTICLE.

The Great Aurora of June 16, 1915.

THERE have been comparatively few auroras here of late years. In that time we have passed through the aurora minimum. Lately, however, there have been distinct indications of an awakened activity in the frequent appearance of auroral glows and arches. But these were generally feeble, and at best showed very little in the way of streamers or other signs of activity.

The night of June 16 was very clear throughout, and gave us one of the finest displays of the aurora that I have seen. Before the moon set there was a very strong, low-lying arch in the north. This was not active, but its intensity seemed to suggest the possibilities of a great display.

At 15h. 30m. G.M.T. the arch was very low and flat, and extended a great distance towards the east and west. There were no streamers.

At 16h. 10m. there were no streamers, but there was considerable action underneath the arch in the way of brightening masses. At 16h. 50m. the arch was double in its eastern part, the upper portion extending to the lower part of Cassiopeia.

By 17h. 10m. the aurora was very brilliant and active, the arch having risen and spread all over the north, nearly as high as the pole. The lower part of the arch was broken with bright moving forms. A few minutes later the arch had risen above the pole, while below it there was very little auroral light except a few streamers. By 17h. 30m. the aurora had quietened down, and the great spasm, seemingly caused by the rising of the arch, had subsided, with the exception of some great bright masses in the north-west, where the remnants of the arch had drifted.

By 18h. 13m. a low, strong arch, slightly active,

had again formed in the north. The new arch soon rose and also became double.

By 19h. 43m. the arch was breaking up, and very long streamers were ascending everywhere. By 19h. 52m. quick waves of light were ascending towards the zenith, succeeding each other with remarkable rapidity. These waves continued without intermission until dawn blotted them out about 21h. 5m.

After about 19h. 40m. the display rapidly increased in magnitude, and attained its maximum splendour at about 20h. 10m. or 15m., when it became too bewildering to describe. The whole heavens seemed alive with flickering and dancing light. The rapid waves of light and the streamers were ascending in all directions, even from the south, to a focus that appeared to be on or near the meridian and about 20° south of the zenith. (Its declination was roughly +23°.) This focal spot was occupied by some of the irregular luminous masses which were momentarily brightly illuminated by these waves. The streamers were no longer slender rays; they were now broad sheets of light along which the ascending waves raced with intense rapidity, giving them the appearance of flames rushing up from the horizon to and beyond the zenith. These quick light waves momentarily and brightly illuminated every object over which they passed. The sky was full of wisps and curved streaks of luminous matter over which the light waves took a sensible moment to pass. This produced a remarkable effect. As the light ran from end to end of them the rapid brightening seemed to give life and action to these streaks and produced in them a writhing and darting motion which they did not possess, for their real motion and change of form was quite sluggish. As late as 21h. 25m., when the sky was bright with dawn, some of the great bright masses were still visible in the north-west.

There was but little colour in the display at any time, though some of the streamers and masses assumed a slight pinkish tinge at about 19 hours. Efforts were made several times to form curtains at the bases of masses of streamers, but no regular curtains were actually formed.

Throughout the night I was photographing with the Bruce telescope. As frequently as possible notes were made of the progress of the aurora. At 20h. 0m. the sky was so brilliantly lighted that I was forced to close the exposure. The resulting negatives were badly fogged with the auroral light, which seemed to be more actinic than moonlight.

The present aurora was much like that of 1903, October 30 (see *Astrophysical Journal*, vol. xxxi., p. 212), in its phenomena and its effects on the telegraph systems, but exceeded it in some respects.

From the newspaper accounts we learn that the aurora was visible over the greater part of the United States and Canada. It was strong even in California.

A despatch to the *Los Angeles Tribune* of June 18, from Spokane (Washington), dated June 17, says:—

"Electrical currents caused by the aurora borealis almost stopped telegraph service in northern Idaho, Montana, and the Dakotas between midnight and 1 o'clock this morning. Up to 9 o'clock this morning the Western Union Telegraph Company reported interrupted service, but not to such a great extent as in the hour following midnight."

In the *Chicago Tribune* of June 18 a despatch from New York, dated June 17, says:—

"Following the spectacular appearance last night of the aurora borealis, which lighted the entire north-west, came reports to-day of crippled telegraph and cable service. The effect of the electricity from the northern lights was felt on wires in a zone stretching across the continent, and as far south as Pittsburgh.